Enabling Docker for Robotic Applications

By Ruffin White
“Amigoni et al. [8] showed that not a single paper among the top cited ones in SLAM and navigation met all the basic criteria listed in the GEM guidelines. We may have clearly improved since then, but probably not enough.”

Motivation

Repeatable
Reproducible
(and Deployable!)
Robotics


Docker... What?

**is not:**

- a Virtual Machine

**is:**

- more like a chroot *on steroids!*

Containers are isolated, but share an OS, and where appropriate, bin/libraries

… resulting in portable RR&D software
Goal: (Open Source) Rapid Prototyping

Web:
- debian
- MySQL
- python
- node
- redis

Robotics:
- Gazebo
- ROS and friends
- pcl
- MoveIt!
- CloudSim
- OpenCV
- SHiP IT!
ROS Tools: Hardware Drivers

cameras
depth cameras
laser scanners
robots
audio
inertial units
GPS
joysticks
etc...
ROS Ecosystem: Variety

Big

Small

Industrial

Vehicles

Air/Water
## Matrix from Hell

|-----------------|---|---|---|---|---|---|---|---|

**Legend:**
- Development VM
- QA Server
- Single Prod Server
- Onsite Cluster
- Public Cloud
- Contributor's laptop
- Customer Servers

*Look how small it is, it's so cute.*
Platforms x Distros x Peripherals = n

The Curse of Dimensionality continues to plague us everywhere

Opps... forgot the about n+1 Libraries

But wait, there's more!

Open Source Robotics Foundation
ROS + Docker... Why?

Repeatability & Reproducibility
for robotic research and industry “is hard…
It should not be hard…”

Make robotic research
within and between labs simpler and more collaborative

Make robotic industrial
deployments maintainable with Continuous Integration

Because who loves going in circles?

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I heard you need to create a robot dataset. Here, I've got a ROS package that does that already.

WHY DOES THE ROBOT KEEP DYING?

Oh, you need to download these 42 packages first.

I already did, and it still doesn't work!

Well, it built fine when I published it 3 weeks ago.

Grr. Package updates...

adapted from xkcd
Let's Simplify

cross compilation complexity
managing custom dependencies
pushing new app and changes for multiple robots

Pushing new Services and Containers

Deployed Field Robots

Researchers and Developers
ROS Launch Demo

From stock linux install to course development environment, provide students a working setup.

Share and submit **running** ROS apps with instructors and teammates using Dockerfiles and images.

Share and submit **broken** ROS apps for collaborative debugging sessions, even keep errors reproducible.

Providing fail-fast learn-fast disposable workspaces, students should experiment without hesitation.

Uses Docker Compose to keep something, that may have many moving parts, simple others to launch

`libnetwork + ros_docker_demos`
Sharing Demos Demo

Two ROS nodes, e.g. mage publisher and a subscriber using Caffe Deep Learning

Nodes run in isolated linux containers on host, yet share exposed cam and GPU hardware.

Repeatable, Reproducible publications, share not only source, but secret sauce to build, run, and ship!

From reading papers to tweaking complex demos locally in the time it takes to download the image.

Use free registries like Docker Hub to share images to inspect and contribute back to build recipes.

ros_caffe/docker
Industry

Cloud Swarm Demo

Deploy multiple nodes from different cloud computing cluster and different networks.

Take advantage of the Docker ecosystem to build, ship and orchestrate swarm of nodes.

Run ROS nodes on AWS, Azure, or Google to finally bring about that singularity of cloud robotics we were promised all those years ago!

Run heavy Gazebo simulations for continuous integration faster and cheaper on clusters.

Orchestrate deployed swarms or field robots and how they network we each other.

gazebo_docker_demos
Currently
leveraging Docker for CI and ROS build farms
as well as sharable development environments

Future
ROS runtime integration with Docker engine API
Launching and managing swarms of nodes
Large scale virtual networking between nodes
Blending of cloud and robotic software tools

> _roslaunch
   && docker-compose
   =the_future!
OSRF maintained base images for your robotic docker projects

Available now on Docker Hub

hub.docker.com/_/ros

hub.docker.com/_/gazebo
A tip of the hat to OSRF & IRIM

Open Source Robotics Foundation

“...to support the development, distribution, and adoption of open source software for use in robotics research, education, and product development.”

Georgia Institute for Robotics and Intelligent Machines

Cognitive Robotics

“...to create new collaborative opportunities for faculty, strengthen partnerships with industry and government, and maximize the societal impact of the transformative robotics research conducted at Georgia Tech..”
Robot Resources!

More on ROS + Docker:
wiki.ros.org/docker

Official Docker Library for ROS:
hub.docker.com/_/ros

ROS Answers Tags:
Docker | Container

Slack channel:
rosorg/messages/docker

About Me: about.me/ruffin